

Application no. 10/727515
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CLMPTO

Claim 1 (Currently Amended): A solid-state image pickup apparatus which incorporates a semiconductor substrate having an image pickup region including unit pixels disposed in a two-dimensional configuration and signal scanning sections for reading signals from the unit pixels in the image pickup region, the solid-state image pickup apparatus comprising:

a photoelectric conversion region having a first-conduction-type signal accumulating section formed at a position apart from a top surface ~~an interface~~ of the semiconductor substrate in a direction of a depth of the semiconductor substrate for a predetermined distance and arranged to accumulate signal charges obtained from photoelectric conversion;

a gate electrode of a first-conduction-type MOS field effect transistor formed adjacent to the photoelectric conversion region and arranged to discharge a signal charge from the first-conduction-type signal accumulating section;

a first-conduction-type detecting node section serving as a drain region for receiving the signal charges from the photoelectric conversion region via the gate electrode; and

a barrier layer formed at least close to a lower part of the first-conduction-type detecting node section of the MOS field effect transistor, wherein

at least a part of the first-conduction-type signal accumulating section in a direction of a channel thereof extends to overlap the gate electrode in a direction in which signals are discharged,

modulation of the potential of the gate electrode is used to discharge signals from the first-conduction-type signal accumulating section through the channel of the MOS field effect transistor, and

the first-conduction-type detecting node section is not located below the gate electrode but at a second side of the gate electrode opposite to a first side of the gate electrode formed adjacent to the photoelectric conversion region ~~an opposite side of the gate electrode.~~

Claim 2 (Currently Amended): A solid-state image pickup apparatus according to claim 1, further comprising a diffusion-layer region which is formed adjacent to the top surface ~~in the interface~~ of the semiconductor substrate above the first-conduction-type signal accumulating section, which has a second-conduction-type opposite to the conduction type of the first-conduction-type signal accumulating section and which contains impurities at a concentration which is higher than the concentration of impurities contained in the channel region of the first-conduction-type MOS field effect transistor.

Claim 3 (Withdrawn): A solid-state image pickup apparatus according to claim 1, wherein a length of a portion of the first-conduction-type signal accumulating section extending to overlap the gate electrode in the direction in which signals are discharged is shorter than 1/2 of a length of the gate electrode of the first-conduction-type MOS field effect transistor.

Claim 4 (Withdrawn): A solid-state image pickup apparatus according to claim 2, wherein a length of a portion of the first-conduction-type signal accumulating section extending to overlap the gate electrode in the direction in which signals are discharged is shorter than 1/2 of a length of the gate electrode of the first-conduction-type MOS field effect transistor.

Claim 5 (Currently Amended): A solid-state image pickup apparatus according to claim 2, wherein a length of a portion of the first-conduction-type signal accumulating section extending to overlap the gate electrode in the direction in which signals are discharged is longer than 1/2 of a depth of a junction of the diffusion-layer region from the top surface interface of the semiconductor substrate.

Claim 6 (Currently Amended): A solid-state image pickup apparatus according to claim 1, wherein the first-conduction-type signal accumulating section has a first region formed below the gate electrode and a second region formed at a position except for a position below the gate electrode, and a depth of the first-conduction-type signal accumulating section in the first region from the top surface interface of the semiconductor substrate is smaller than a depth of the first-conduction-type signal accumulating section in the second region.

Claim 7 (Currently Amended): A solid-state image pickup apparatus according to claim 2, wherein the first-conduction-type signal accumulating section has a first region formed below the gate electrode and a second region formed at a position except for a position below the gate electrode, and a depth of the first-conduction-type signal accumulating section in the first region from the top surface interface of the substrate is smaller than a depth of the first-conduction-type signal accumulating section in the second region.

Claim 8 (Currently Amended): A solid-state image pickup apparatus according to claim 3, wherein the first-conduction-type signal accumulating section has a first region formed below the gate electrode and a second region formed at a portion except for a position

CLAIMS 11-19 (CANCELLED)